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A detailed diagram of a computer keyboard layout, showing the arrangement of keys and the corresponding finger placement for typing. The keyboard is divided into several sections: CONTROL, CAPITALS, SPACE, and the main alphanumeric area. The alphanumeric area is further divided into four columns, each associated with a specific finger: index finger (left), middle finger (left), ring finger (right), and little finger (right). The keys are numbered 1 through 41, indicating the sequence of finger movements. The diagram also shows the placement of the thumb, index, middle, ring, and little fingers on the keyboard. The keyboard is labeled with 'CONTROL', 'CAPITALS', 'SPACE', 'index finger', 'middle finger', 'ring finger', 'little finger', and 'thumb'. The keys are arranged in a grid, with the alphanumeric keys in the center, the function keys (esc, del, bs, lock, sp) on the left, and the numeric keypad on the right. The keyboard is shown from a top-down perspective, with the keys and their corresponding finger placement clearly visible.

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KEYBOARDS AND METHODS OF OPERATING KEYBOARDS

The present invention relates to keyboards for operation by human hand digits to signify letters of an alphabet and/or other units of information by generating signals indicative of the letters or other units of
05 information, and also relates to methods of operating keyboards.

The invention is concerned in particular with keyboards intended for operation by only a single human hand, but in some aspects the invention is concerned with
10 keyboards intended for use by two human hands. The invention is concerned particularly with keyboards for operation to signify letters of an alphabet, but in some aspects is concerned with keyboards for operation to signify other units of information, including numerals
15 and/or musical symbols. In some aspects the invention is concerned with a novel layout of the keys relative to each other, and in other aspects the invention is concerned with the functions of the keys, and/or the shaping of the surfaces of the keyboard. With the
20 increasing trend towards the miniaturization of information processing equipment, and with the increasing need for people to have access to information processing equipment whilst doing other operations at the same time, there is an increasing need for a small and/or single
25 handed keyboard for information input. If a small



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keyboard is to be used at speed, it has been found that the keyboard should preferably be designed for use by one hand as there is not room for two hands on a small device.

05 Until now, there have been two broad classes of keyboard available for small alphanumeric input devices. The first and most common arrangement has the keys in a rectangular matrix based on the traditional typewriter layout QWERTY... or on the alphabetical order layout
10 ABCD... Whilst these arrangements are comparatively easy for the unskilled user to operate, it is impossible to use such an arrangement at any speed, because only one or two fingers can be used at once, and it is necessary to look at the keyboard to locate the keys.
15 Even so, because the keys are so close to each other, it is easy to mis-key.

The second broad class of small keyboard is the chord keyboard. This has a small number of keys but a larger number of characters can be created by using
20 the keys in various combinations, referred to as chords, in the same way that chords of musical notes are played. Although operation may be more complicated, in a simplified view there may be provided one key per finger, and these keys may be depressed singly or in combinations
25 to create the letters of the alphabet, numerals and so on.

A third form of keyboard which has relevance to



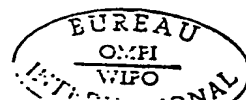
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some aspects of the present invention, is provided by the more modern forms of two handed keyboards, in which the key arrangements are shaped to take account of the shapes of the normal pair of human hands, and in which
05 the configuration of letter allocation to the keys takes into account the frequency of use of letters.

There will now be described examples of the known types of keyboard set out above.

Two examples of a small keyboard suitable for use
10 by a single hand but having the keys in a conventional rectangular array consist of the Lexitron Translator keyboard, and the Canon Communicator keyboard. The former consists of a small conventional rectangular array of keys labelled in normal alphabetical order and is used
15 as input to the electronic translation device. The Canon Communicator is a communication aid for partially disabled persons and provides a printed paper output in response to operation of letter keys in a rectangular array. In the Canon Communicator, the letter order is
20 not an alphabetical order, but is an arrangement in which commonly used letters are placed at the outside of the array, to avoid mis-keying for example by a disabled person operating a mouth stick.

An example of a chord keyboard is a keyboard known



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as the Microwriter which consists of a single handed keyboard having five normal keys positioned in the shape of a human hand for operation by the five digits of the human hand, together with two control keys operable by the thumb. A number of characters much larger than the number of keys can be obtained by pressing the keys singly or in combinations including combinations with the thumb control key. Although the Microwriter attains compact size by using few keys, it has a number of disadvantages. Operation of the device is slow, and it is easy to make errors since most characters require more than one key to be depressed simultaneously. The device is not easy to learn, since the mnemonics employed are not intuitive. The device is also limited in the range of characters expressible. A description of the Microwriter device can be found in the following reference:-
Mussin E.H. "The Microwriter", IERE Electronic Office Conference Proceedings. April 1980.

Another single handed keyboard which has been proposed is the IBM so-called "Chord Keyboard" which has only ten finger keys, but uses the spaces between the keys, by means of finger shaped dimples, to create a full range of numerals, letters and so on. Depression of any dimple shape will produce depression of one, two or four keys. The IBM keyboard also allows depression of multiple dimples at once, and, with the addition of the thumb keys, can therefore obtain a very large number



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of combinations, including some words and parts of words,
in single movements. The key pattern is that the thumb
keys are off-set to one side of the main keyboard, but
the main keys are set out in a strictly rectangular
05 array which is unrelated to the shape of the human hand.
A description of the IBM keyboard can be found in US
Patent Specification No. 4042777 (Bequaert and Rochester).
A keyboard similar in some ways has been developed in
the UK by Loughborough Consultants Limited and a des-
10 cription can be found in UK Patent Specification No.
1492538 (Loughborough Consultants Limited).

Becuae of the extra time needed to form a chord,
compared with tapping a single key, both the Microwriter
and the IBM keyboards are slower than the traditional
15 two handed keyboard, even if used by a skilled user.
The Microwriter also has the disadvantage that it has
the limited repertoire of characters (a limitation
particularly acute when this range is compared with
that offered on a modern word processing editing terminal)
20 so that a series of chords is required in order to obtain
many of the characters or commands required.

The IBM keyboard also has the disadvantage that
considerable training is needed in order to attain a
moderate level of proficiency, and use of the keyboard
25 is more tiring, as well as requiring more skill, than
use of a traditional two handed keyboard. Both keyboards



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also have the disadvantage that they have to be taught before use. It is virtually impossible, even for an intelligent person, to start to operate the keyboard even at a rudimentary level, without instruction.

- 05 An example of the two handed keyboard in which the key configuration is shaped to some extent to the human hand, is a keyboard known as the Maltron keyboard developed by a UK Company PCD. This keyboard has been ergonomically designed for two handed use and is faster
- 10 than a standard Qwerty keyboard. Except for speed it has most of the disadvantages of the Qwerty keyboard, in particular it is bulky, and is probably only suitable for professional typists. A description of the Maltron keyboard can be found in the following reference:
- 15 Malt, Lillian G., "Keyboard Design in the Electronic Era." PIPA Eurotype Forum, Conference Paper No. 6, 14-15 September 1977.

In accordance with another aspect of the present invention, the invention is concerned with the type of

20 motion employed by the fingers during information input on a keyboard. Keyboards, even musical keyboards, have traditionally used a tapping motion. This is left over from the days when mechanical switches or keys needed to be pressed a substantial distance in order to operate

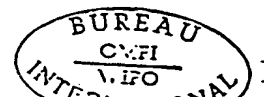
25 the mechanism to which they were attached. Today, even on capacitive and other kinds of switches which need no actual movement to operate, it is still assumed in known devices that they will be operated by a tapping movement.



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Traditional two-handed keyboard designers have tried to arrange the layout of the keyboard such that most of the frequent digrams (combinations of characters) are typed with alternate hands, as the tapping movement from one hand to another is in most cases faster than a tapping movement from one finger to another on the same hand. A one-handed keyboard cannot take advantage of the increase in speed to be gained by tapping from hand to another and, therefore, a one-handed keyboard relying on the tapping principle is likely to be slower in operation than a two-handed keyboard. One of the objectives of the IBM chord keyboard use of chords is to reduce the number of movements necessary and therefore to make up this loss of speed. However, because of the extra complexity of creating the chords, this has not been very successful.

In accordance with yet another aspect of the invention, the invention is concerned with the shaping of keys and the keyboard surface. It is now accepted practice to dish the top surface of a typewriter key to help the finger to correctly locate itself on the key which it is striking. In addition some of the better machines aim to give more "tactile feed back" by differentiating the "feel" of the home keys (keys on which the fingers are usually considered to be based when at rest). This may be done by providing small



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projections on the surface of the key for the finger to feel, by changing the shape of the dishing, or by changing the pressure required to operate those particular keys.

05 In addition, some keyboards which do not use moving switches, have had the sensitive surface of the switches thereof set into recesses so that the recesses aid in correct location of the keys, and the raised surface between keys aids in discouraging mis-keying.
10 However such recesses have not been applied selectively to key configurations and have merely been uniform recesses for the keys. Also, most keyboard surfaces which use keys with very small travel or no travel have tended to be completely or nearly flat and therefore
15 give very little or no tactile help with finger location. An audible tone is often used to tell the operator when the key has registered, but this does nothing to discourage mis-keying or to help with finger location.

It is an object of the present invention to combine,
20 in a number of different aspects, a number of features concerning the key configuration, and/or character allocation, and or manner of operation, of a number of forms of keyboard.



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According to the present invention in a first aspect there is provided a keyboard for operation by human hand digits to signify letters of an alphabet by generating signals indicative of the letters, comprising
05 a base, and a plurality of keys including a plurality of letter keys each operable by a human digit to signify a letter, in which any one of all of the letters of the alphabet concerned can be signified by operation of only a single human hand without substantial movement of the
10 whole hand across the keyboard, the configuration of the keys and/or the configuration in which the letters are allocated to the letter keys is or are related to the shape of a single human hand, and in which there are provided a plurality of letter keys, referred to as
15 principal letter keys, positioned to be associated with the three strongest fingers of the human hand, in which at least a majority of the letters of the alphabet, including the most commonly used letters, are allocated to the principal letter keys, and in which operation of
20 no more than one at a time of the principal letter keys is required when signifying any letter of the alphabet.

The keyboard will usually include a number of keys other than letter keys, for example shift keys for producing capital and lower case letters, and for
25 producing numerals from the letter keys when in the appropriate shift arrangement. Normally it will be



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preferred that all the letter keys form principal letter keys, but in some arrangements a few of the least used letters may be placed on letter keys positioned to be associated with fingers other than the three strongest
05 fingers of the human hand.

Normally the keyboard in accordance with the invention will have both the configuration of the keys and the configuration in which the letters are allocated to the letter keys, in a shape related to the shape of a
10 single human hand, but in some applications the configuration of keys may be a plane flat rectangular array with only the letter configuration related to the shape of a single human hand, and in other applications the configuration of keys may be in the shape of a single
15 human hand, but the letter allocation may be a simple alphabetic or conventional QWERTY, arrangement. Where the configuration of the keys is related to the shape of a single human hand, this may be effected by the layout of the keys in a single plane, and/or in different
20 planes, and/or by contouring of the base of the keyboard.

Preferably the said configuration of the keys is related to the shape of a single human hand at least in that the keys are positioned to take account of the difference in length between the longest finger and the
25 other two strongest fingers of the human hand so as to allow the three strongest fingers to rest comfortably



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on three keys, or on three transverse pairs of keys, respectively, of three different groups of principal letter keys when the hand is at rest. The keys, or transverse pairs of keys on which these fingers rest
05 are generally referred to as the "home" keys.

In some preferred configurations this feature of allowing for the different lengths of the three strongest fingers of the human hand can be achieved by having the keys arranged in a matrix of columns of keys generally
10 longitudinal of the fingers and rows of keys generally transverse of the fingers, in which the said comfortable rest position of the three strongest fingers is achieved at least in part by arranging the transverse rows to be curved and/or stepped. Alternatively or in addition,
15 the said comfortable rest position of the three strongest fingers can be achieved at least in part by having the pitch between transverse rows of keys substantially equal to the difference in length between the longest finger and the other two strongest fingers of the human
20 hand.

Preferably the said configuration in which the letters may be allocated is arranged so that the most commonly used letters can be signified by the operation of principal letter keys at or close to the natural rest
25 position of the three strongest fingers of the human hand.

Most preferably the said principal letter keys are



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arranged in three groups positioned for the groups to be associated respectively with the three strongest fingers of the human hand, and it is especially preferred that each said group of letter keys comprises at least one
05 column of three or more letter keys positioned to allow keys of the column to be reached by movement of a human finger forward and backward relative to the body of the user.

In general it is preferred that all the letter
10 keys are positioned for operation, in normal use, by the fingers of the human hand. This will normally leave the thumb free for operation of shift keys and the like.

As has been mentioned, it is preferred that all
15 the letter keys are arranged as principal letter keys, and it is further preferred that all the letters of the alphabet are allocated to principal letter keys, and that any letter of the alphabet can be signified by an action consisting only of operation of one appropriately
20 selected letter key. The advantage of such an arrangement is that the three strongest fingers of the human hand are used for the main function of producing letters, in each case by a single stroke of one of the main three fingers of the human hand, leaving the little finger and
25 thumb free for operating shift and other control keys.

In accordance with one particular group of



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embodiments of the invention, there may be provided mode selector means operable by movement of the said single human hand without substantial movement of the whole hand across the keyboard, said mode selector means being
05 operable to select different modes for the letter keys such that operation of a letter key in different modes causes switch means to generate signals indicative of different letters, and/or different forms of the same letter, and/or different non-letter items of information.

10 In a preferred form of this class of embodiments, the letters of the alphabet concerned are divided into two or more classes of letters selectable in respective modes by the mode selector means, the letter keys are operable to signify different letters from different
15 classes depending on which class has been selected by the mode selector means, and in which any letter of the alphabet concerned can be signified by operation of only a single letter key at a time, provided that an appropriate mode selection is made by operation of the
20 mode selector means.

Such an arrangement allows a large number of letters and other units of information to be provided from a relatively small number of keys on a one handed keyboard. Preferably the said mode selector means
25 comprises a mode key positioned for operation, in normal use, by a human digit other than the three strongest



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fingers of the human hand. In a convenient form of this arrangement, the said mode selector means comprises a switching device associated with the said base of the keyboard and operable by a rocking motion of the said base and arranged to be operated in normal use
05 by a rocking motion of the whole said single human hand.

In the preceding paragraphs a number of features of the invention have been set out in a first aspect of the invention, and there is also provided in accordance
10 with this first aspect of the invention a method of generating signals indicative of letters of an alphabet by operating letter keys of a keyboard by touch of human digits on the keys and by generating signals indicative of letters by actuation of switch means associated with
15 the keys, the method comprising the steps of signifying any of all of the letters of the alphabet concerned by operation of only a single human hand without substantial movement of the whole hand across the keyboard, operating the keys when arranged on the keyboard in such a manner
20 that the configuration of the keys and/or the configuration in which the letters are allocated to the letter keys is or are related to the shape of a single human hand, and associating a plurality of letter keys, referred to as principal letter keys, with the three strongest
25 fingers of the human hand, at least a majority of the letters of the alphabet, including the most commonly



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used letters, being allocated to the principal letter keys, and signifying any one of all of the letters of the alphabet by operation of no more than one at a time of the principal letter keys.

05 Preferably in this method the said principal letter keys are arranged in three groups, and the method includes the step of associating the three groups of principal letter keys respectively with the three strongest fingers of the human hand. Most preferably
10 each said group of letter keys comprises at least one column of three or more letter keys, and the method includes the step of reaching the different keys of the column by movement of a human finger forward and backward relative to the palm of the human hand.

15 In the method of the invention it is generally preferred that all the letter keys are arranged as principal letter keys, all the letters of the alphabet are allocated to principal letter keys, and the method includes the step of signifying any letter of the
20 alphabet by an action consisting only of operation of one, appropriately selected, letter key.

In accordance with the first aspect of the invention which has been set out above, various embodiments may be constructed giving a number of practical advantages
25 and features, and some of these features will now be described.



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The keyboard is conveniently layed out so that each digit has arranged beneath it, in columns corresponding to the position of each of the digits when the hand is held relaxed on a surface, a number of keys
05 designed for the use of that digit. Clearly the keyboard can also be used as a single-finger "hunt and peck" operation, but the keyboard will be discussed in this specification in terms of the way the fingers operate for touch typing.

10 Considering firstly the key layout in relation to the fingers, the index, middle and ring fingers are the three most agile and strongest of the four fingers, and these are therefore made responsible for most of the movement, in accordance with preferred arrangements
15 of the invention. The keys relating to most of the letters of the Roman alphabet are laid out beneath these fingers for their use, and only one of these three fingers needs to be used at any one time to access any of the 26 letters of the Roman alphabet. Thus none of these
20 fingers need ever be used in a chord in combination with any of the others of the three main fingers to create a single character.

Given that it is desirable to restrict the number of keys on the keyboard to a lesser number than that on
25 the traditional QWERT keyboard, and given the need to generate enough characters from the keyboard, it is



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necessary to obtain multiple character sets from each of the keys arranged for the use of the index, middle and ring fingers. The principle of the "SHIFT" key to be used simultaneously with another key, is well established on other keyboards and is continued in preferred arrangements of the present invention, as is the use of a "CONTROL" key, which is effectively another "SHIFT", on keyboards for computer equipment. In addition, to further cut down the number of keys necessary, the range of output characters can be divided into two or more "modes", as has been set out above. Whilst it would be possible to lock the MODE key or SHIFT or CONTROL in place, it is preferable to be able to key them simultaneously and momentarily with the relevant letter key.

Whilst the thumb is strong, it is limited in its range of movements relative to the other fingers. However it can conveniently operate control keys like CONTROL and CAPITALS simultaneously with the other fingers when necessary.

If the little finger then operates a MODE key or keys (to change for example to a NUMERALS AND PUNCTUATION mode) this key or keys can be operated simultaneously with the keys operated by the thumb.

In accordance with another feature of the invention, these control keys (CONTROL, CAPITALS and MODE) are elongated parallel to and to a length corresponding to



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the length of the keys which are arranged for the use of the character-forming fingers. By this means, these keys may be operated simultaneously with any of the keys under the three character-forming fingers, without
05 any awkward stretching being necessary. This lengthening means that these control keys can be conveniently reached from any position on the keyboard.

There will now be set out a number of features of the invention in accordance with a second aspect of the
10 invention.

According to the present invention in a second aspect there is provided a keyboard for operation by digits of one or both human hands to signify units of information by generating signals indicative of the units
15 of information, comprising a base, and a plurality of keys operable by human digits, the base and/or at least some of the keys being contoured differently in respect of different keys in such a manner as to effect or enhance operation of the keyboard during substantially
20 planar movement of a digit of the human hand consisting of movement substantially in or parallel to the plane of the keyboard.

The contouring referred to is preferably applied both to the base of the keyboard and to the keys thereof,
25 although it is to be appreciated that in some cases contoured keys may be provided on an otherwise flat



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keyboard, or alternatively a contoured base may be provided for the keyboard, with the keys either flat or having a conventional dished shape common to all the keys. The invention as set out in this aspect is particularly concerned with improving keyboard operation by substantially planar movement of digits of the human hand, but it is to be appreciated that the contouring may also give advantage during conventional tapping movement of digits.

10 In some preferred arrangements, the said contouring is such as to enforce or assist movement of a human digit from one key to another of certain predetermined sets of keys, and/or to prevent or inhibit movement of a human digit from one key to another of certain pre-
15 determined sets of keys, during said substantially planar movement of a human digit.

In a particularly preferred arrangement the keys are arranged in a pattern providing groups of keys, the keys of each group being positioned for operation
20 selectively by a single human digit associated in operation with that group, and said contouring is arranged to prevent or inhibit said substantially planar movement of the human digit between the keys of the group with which the digit is normally associated to the keys
25 of another group. Conveniently the said contouring comprises a raised barrier portion or portions of the



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base running between adjacent groups of keys, but in other arrangements the contouring may comprise placing the groups of keys apart with a depression between the groups, or placing the groups in slightly different
05 planes. The term substantially planar movement of the human digit is intended to refer to planar movement in the general plane of the keyboard, as opposed to tapping movement at right angles to the general plane of the keyboard, but it is to be appreciated that in some
10 circumstances some keys or key surfaces may be positioned at slightly different planes relative to the main general plane of the keyboard.

The invention in the second aspect finds particular application where the keys are arranged in a pattern in
15 which certain sets of keys are operable to signify letters or other units of information which commonly occur in sequence, and said contouring is such as to enforce or assist movement of a human digit from one to another of the keys in a set related to such a sequence, during said
20 substantially planar movement of the human digit.

Examples of such sets of letters which occur in sequence are the letters T and H, and the ~~letters~~ E.R. Other combinations may be found in alphabetical letters, and also, for example, in musical notation, where
25 musical notes constitute units of information which may be signified by the keyboard.

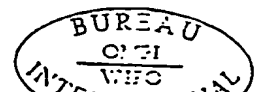


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In this particular respect, the invention is concerned with the motion by which keys are made to operate. Instead of relying on the traditional tapping motion, a keyboard may be designed to be operated by a sliding motion. Because the finger does not need to leave the surface of the switch, motions from one key to another can be faster than if the finger has to be lifted from one key to another in a tapping motion. For the keys to operate through a sliding motion, it is necessary to use keys with a small travel or keys with no travel at all such as is found on a capacitive type key pad.

In another form of the second aspect of the present invention, the invention is concerned with the shape and operation of individual keys. In accordance with this feature, at least some of the keys are contoured to provide a surface inclined to the horizontal for contact by a human digit such that during said substantially planar movement of a human digit, a force derived from the planar movement of the digit is translated by the inclined surface of the key into a force generally at right angles to the plane of the keyboard to operate the key.

In connection with this feature, and the preceding features, at least in preferred embodiments thereof, the invention is concerned with a number of details of



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the shaping of the surface of the keyboard and keys to make the sliding motion more easy and effective and to increase the tactile feedback which will enable the user to avoid errors and to key faster. Raised mouldings
05 on the keys can have contoured sides such that a horizontal movement of the finger, striking against the moulding, will produce a downward motion in the moulding, and therefore in the key switch operated by the key.

10 If the mouldings on each key differ in shape or size then the user can feel readily whether the correct key or incorrect key is being pressed. Suitably shaped raised mouldings (in combination with the fact that the keys do not have any substantial travel) also enable
15 the keys to be set closer together but still to be keyed individually, without also, inadvertently, operating another key.

The further the movement required in keying, the longer it takes, and the more difficult it is, particularly if other keys are having to be hopped, to
20 make sure that the movement ends accurately and on the right key. If the key surface edge moulding is substantially raised for keys which are at a distance from the home position, those keys will offer a greater
25 target area for the moving finger, and will therefore be more easily struck and more rapidly struck than would be



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the case if they were the same size as other keys.

As has been mentioned, there may also be provided in accordance with the invention raised mouldings or barriers between the fingers. These may serve three
05 purposes. They may act as a stop for side-to-side movement of the finger and thus help the finger to locate itself on the keys at either side of the finger column. The finger barriers may stop the fingers mis-keying by inadvertently hitting a key in the adjacent column
10 supposed to be used by the adjacent finger. Finally the presence of the barrier may enable the keys to be spaced closer to each other without running the risk of one key depression fouling another.

There are also provided in accordance with the
15 second aspect of the present invention a number of method features.

In accordance with the second aspect of the invention there is also provided a method of generating signals indicative of letters of an alphabet or other
20 units of information by operating letter keys of a keyboard by touch of human digits on the keys and by generating signals indicative of letters by actuation of switch means associated with the keys, the method including the step of operating certain sets of keys
25 which signify letters or other units of information which commonly occur in sequence, said operation being



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effected by moving a human digit from one to another of the keys in such a set by a substantially planar movement of the human digit consisting of movement substantially in or parallel to the plane of the keyboard.

05 There is further provided in accordance with the second aspect of the invention a method of generating signals indicative of units of information by operating keys of a keyboard by touch of human digits on the keys and by generating signals indicative of other units of
10 information by actuation of switch means associated with the keys, the method including the step of operating a key by a substantially planar movement of a human digit consisting of movement substantially in or parallel to the plane of the keyboard, the operation comprising
15 contacting the human digit against an inclined surface of the key during the said planar movement, and translating, by the effect of the inclined surface, a force derived from the planar movement of the digit into a force generally at right angles to the plane of the
20 keyboard to operate the key.

It is to be appreciated that the various features set out in accordance with the two aspects of the invention may equally well be applicable in combinations with each other. In particular there may be provided
25 a keyboard as set out in accordance with the first aspect of the invention in which the base and/or at



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least some of the keys is or are contoured in such a manner as to effect or enhance operation of the keyboard during substantially planar movement of a digit of the human hand consisting of movement substantially in or
05 parallel to the plane of the keyboard.

Embodiments of the invention will now be described by way of example with reference to the accompanying drawings in which:-

Figure 1 is a plan view of a preferred keyboard
10 embodying the invention, suitable for right-handed use;

Figure 1(a) is a cross-section taken length ways through the keyboard through the keys disposed for the use of the index finger, along the lines A-A in Figure 1;

Figure 1(b) is a cross-section from side-to-side
15 of the keyboard through the first row of keys, along the line B-B in Figure 1;

Figure 1(c) is a cross-section from side-to-side of the keyboard through the keys disposed for the thumb and little finger, along the lines C-C in Figure 1;

20 Figure 2 is a plan view of two adjacent keys for use by the same finger, showing the marking of legends and the positioning of contoured mouldings on the key;

Figure 2(a) is a side-to-side cross-section along the lines A-A in Figure 2, through the same two keys,
25 showing the mouldings and demonstrating how the keys may be depressed through a sideways movement of the finger;



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Figure 2(b) is a front-to-back cross-section along the lines B-B in Figure 2, through one of the two keys, showing the moulding and demonstrating how the keys may be depressed through a sliding movement of the finger
05 towards or away from the palm of the human hand;

Figure 2(c) is an isometric view of a key, showing the moulded contours;

Figure 3 shows a detail of another keyboard embodying the present invention, and using mouldings
10 between adjacent groups of keys, the keys being arranged on diagonal instead of transverse horizontal rows;

Figure 4 shows another keyboard embodying the invention having an alternative plan of the keyboard with some letter keys allocated to the little finger
15 and with keys arranged along diagonals rather than in horizontal transverse rows;

Figure 4(a) shows in diagrammatic form the detail of a particular key of the keyboard of Figure 4;

Figure 5 shows a further alternative keyboard
20 embodying the invention, and illustrates a version with fewer letter keys, intended for use in at least two modes, where the mode changes are intended to be operated through rocking the whole keyboard on switches positioned on the underside of the keyboard;

25 Figure 6 shows a length ways cross-section of the keyboard of Figure 5, and indicates the mode switches



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and a raised hand-rest bar;

Figure 7 shows cross-sections of various different contoured mouldings which can be used to form the upper surface of keys for use in a keyboard embodying
05 the invention;

Figure 8 is a block circuit diagram showing how a keyboard embodying the invention may be connected to a computer, printer, or other output or storage device, for utilisation of signals generated representing
10 letters and/or other units of information; and

Figure 9 shows diagrammatically a switch suitable for use with the keys of a keyboard embodying the present invention.

Referring firstly to Figures 1 to 2(c), especially
15 initially Figure 1, a keyboard 20 comprises a base 21 on which are mounted a plurality of keys indicated generally at 22 and including letter keys 23 and control keys 24. The keys 22 are laid out generally in the shape of a human hand, in that the control keys 24 to the
20 left are intended for operation by a human thumb, and the control keys 24 to the right are intended for operation by the human little finger. The letter keys 23 are intended for operation by the three strongest fingers of the human hand and are grouped in three groups
25 indicated at I, II, and III, for use by the index finger, middle finger, and ring finger respectively.



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Conveniently the keyboard occupies an area 6.1 inches square (157mm x 157mm). These dimensions could be changed for larger or smaller hand sizes and in particular the keyboard could be made considerably smaller as discussed under section 5 below.

The columns of keys are laid out as shown, one for each of the index, middle and ring fingers. Between and either side of these columns are raised barriers (25) approximately 2mm thick and 10mm in height. These barriers separate the fingers from each other, discourage fingers from hitting keys in the wrong column, help to guide the fingers on to the right position for operating the keys, and enable the keys to be positioned closer together than would otherwise be the case.

The keys (23) are laid out so that for each finger there are five rows of keys and two columns. The keys are approximately half an inch square (12mm). The bottom row of the middle finger's column consists of a double key, two keys wide, to perform the ENTER/CARRIAGE RETURN function. At the top of each finger column is left a space for an extra row of keys, six in all, reserved for other use, e.g. for accent keys in foreign languages.

It should be noted that although the embodiment has been designed for the English language, it will be suitable, with minor alterations, for other languages.

On the top surface of each key (23), along the edge closest to the operator, is a raised and contoured moulding (26). Its cross section and design are shown in Figures 2



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- 2C. These mouldings, about 3mm high from the flat surface of the key at their highest point, are designed to convert a horizontal, sliding motion of the finger, into a vertical depression of the key.

05 The switch incorporated in each key is a switch requiring low operating pressure (e.g. 160gms) and short travel, (e.g. 0.3mm) such as the FES-310 range from Fujitsu Ltd, with the moulding applied to the surface 19, depression of which operates contacts 18 (Figure 9).

10 The shape of the mouldings on the surface of the key (as shown on Figure 2C) is designed such that a backwards movement of the finger, e.g. from "t" to "r" will automatically tend to depress the "r" key, a forwards movement, e.g. from "r" to "t" will automatically tend to depress the
15 "t" key, and a sideways movement from "t" to "h" or "h" to "t" will also tend to automatically depress the "h" or "t" respectively. Similarly a diagonal movement, e.g. from "h" to "r" or from "e" to "t" will also tend, because of the contouring of the mouldings, to depress the key the
20 finger is sliding on to.

 These sliding movements can be continued over more than one key, so that, for instance, the word "THEM", "THERE", "THEY" can all be "typed" in a single rapid movement. These mouldings operate in the same way on all
25 three fingers. This ability to slide between common words brings a secondary advantage: it is easier to learn the positioning of the keys on the keyboard because remembering the words will help the user to remember the relative

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position of the keys.

A home position is marked on each of these three columns by a small raised tit⁷at the junction of the "r" and "e" keys on the index finger, the "n" and "s" keys on the middle finger, and the "o" and "u" keys on the column for the ring finger. This corresponds fairly closely to the position taken by the relaxed hand when the hand is laid on the keyboard.

Within the columns for each finger, the raised mouldings (26) at each row extend for different lengths over the bottom of the keys. Thus, whilst the moulding on the bottom row, the Z, Q, V, B, X and J keys, is continuous, stretching over the whole of the bottom of each key, the moulding for the home keys is shorter, stretching only half way over the bottom of the key. The mouldings on the keys immediately above the home row are the same length as the mouldings on the home row, and the mouldings on the other rows of keys are longer, in regular steps, the further the keys are from the home row.

The reason for this difference in the length of the mouldings is so that each finger can feel, from the feel of the moulding beneath it, (which will vary according to how far across the bottom of the key the moulding stretches) which key the finger is pressing. "Tactile feedback" will help the operator to know instantly from its feel which key is being operated. This will lessen the likelihood of error, speed up operation, and, if an error is made, make it immediately obvious so that it can be corrected straight



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away. With this arrangement, it should be noted that, for each finger, each key will feel quite different from any other key laid out for the use of that finger.

The ENTER/CARRIAGE RETURN key in column II has an even
05 higher moulding (28), rising some 10mm from the surface of the key. Keys in the reserved position would preferably also have a similar enlarged moulding. The reason for this is as follows.

It is logical to lay the keys out so that the commoner
10 keys for each finger are disposed either beneath or adjacent to the home keys, and this arrangement has been followed on the keyboard shown. The consequence of this is that the further away from the home keys a key is (the ENTER key being the furthest away for the middle finger)
15 the longer a movement is likely to be to operate that key from the preceding keystroke. Because the movement is longer in distance, it is also likely to take longer in time and, because it involves hopping over other keys, it is more likely to result in miskeying and error. By
20 increasing the size of the mouldings on the keys furthest from the home keys, i.e. the ENTER key and the RESERVED keys, the target area for such long finger movements is considerably increased. This means that the finger can move faster towards the larger target area and still be
25 likely to strike it cleanly and without fouling any of the other keys.

Each column or each row of keys preferably uses keys of a



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different colour, to encourage differentiation, and the CARRIAGE RETURN key is again a different colour to make clear its particular identity.

With the keyboard in its normal state, unaffected by
05 CONTROL, CAPITAL, or NUMBER keys, the keyboard will
output the correct computer code for the lower case letters
of the roman alphabet and the lower case graphic signs
illustrated. The keyboard will transmit the codes for other
characters, (CONTROL, CAPITALS, NUMBERS, CAPITAL NUMBERS,
10 and CONTROL NUMBERS) according to which other key or keys
is or are pressed simultaneously with the letter keys
detailed above. The other characters to be generated are
also shown on the keytops (it may also be preferable
instead to show the layout of less common key characters on
15 a separate sheet or card for the sake of clarity and
simplicity.)

Beneath the thumb keys, arranged beneath and according
to the resting position of the thumb, as shown, are three
columns of keys for the use of the thumb. To the right,
20 and with a small tit on its surface showing the home
position, is a SPACE key operated in the same way as on a
traditional typewriter. Above and below this are
punctuation keys which, when depressed, output the
characters for a full stop and space, and a comma and
25 space. Because in normal (non numeral) text the full stop
and the comma are always followed by a space, keystrokes
can be reduced and therefore keying speeded up, by
combining the space character with the punctuation



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character.

The SPACE key (29) is two keys long so that it can readily and easily be located no matter where on the keyboard the last key had been struck before the space.

05 The CAPITALS and CONTROL keys (32, 33) operate similarly to the way they operate on a normal typewriter or computer keyboard. That is to say they are held down momentarily before the key that it is desired that they should modify and released momentarily after the last key desired to be
10 modified. These two keys are considerably longer (four keys long) than a normal key so that they can conveniently be depressed without awkward stretching, no matter where on the keyboard is the key which it is desired that they should modify.

15 A CAPITALS LOCK (34) is also provided which, when it is depressed will automatically set the keyboard in capitals mode until the LOCK key (34) or CAPITALS key (32) is depressed again. By using this key, it will therefore be possible to type in capital letters whilst still using
20 ordinary numerals (rather than the keys allocated as "capital" numerals) without needing to keep operating the CAPITALS key. A LED indicator (35) is provided to show when the CAPITALS lock is in operation.

On each of the CONTROL, CAPITALS and SPACE keys (24),
25 there is, as shown, a moulding (36) stretching along the keys, with the objective, again, of helping finger location on the right key. The profile of the moulding is



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different, however, from that of the character keys (23) as it is not designed to help sliding from key to key for the thumb, but is, nonetheless, designed to help an easy slide lengthways along the keys.

05 A repeat key (37) is also provided adjacent to the thumb keys which, if it is held down simultaneously with one of the other keys, will cause a string of characters to be output as long as the two keys are held depressed.

10 Arranged conveniently beneath the little finger are two columns of keys (24). In one is the NUMBERS key (38) and NUMBERS LOCK (39) and in the other is the WORD key and TAB key (41).

15 The NUMBERS key (38) operates in a similar way to the CAPITALS or CONTROL key. That is to say when the NUMBERS key is depressed simultaneously with other keys it changes the register of characters available from the letters register to the numerals register. The operative characters are listed on the other side of the key from the letters, as shown on Figure 2. Thus, when the numbers key
20 is held depressed and the "h" key is then depressed, the code for the character "1" will be output. If the numbers key and the capitals key are both held depressed and the "h" key is depressed then the "<" sign will be produced.

25 For convenience the numerals are laid out on the keyboard in the same order and layout (relative to the home positions of the fingers) as the numerals on a telephone pushbutton keyboard, thus making them easier to locate and remember.



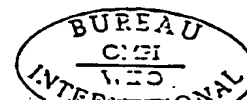
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The relationship of all the other punctuation and symbols keys to the positions on the keyboard or the letters on the keys which generate them is also, as far as possible, designed to be easily memorable. A LOCK key
05 (39), with LED indicator (42), is also provided for the numbers function so that, for instance, a series of numbers can be input without needing to hold the NUMBERS key down.

By means of the NUMBERS, CAPITALS and CONTROL keys, a total of six different characters can be output for each
10 key on the keyboard (if CONTROL and CAPITALS can be held down simultaneously, with the addition of a CONTROL/CAPITALS key, the total number would be eight per key). Thus, excluding ancillary keys, a total of 170
15 different characters can be created with the keyboard as shown (28 x 6 + ENTER and SPACE). With the possibility of CONTROL and CAPITALS being depressed simultaneously, the total reaches 226.

On the keyboard are located a number of ancillary keys (40): BREAK, TAB, ESCAPE, DELETE, BACKSPACE, HOLD, which
20 may be operated by whichever finger is convenient. They are located around the keyboard in such a way that they are less likely to be miskeyed, which, in the case of the BREAK key, could have disastrous effects. They are not affected by the control keys.

25 The electronics of the keyboard are standard electronics such as are commonly used in keyboards and the requirements will be apparent to those versed in the art of



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keyboard electronics. The character keys are electrically connected into an X-Y matrix type array. The matrix is scanned electronically which may be achieved by any of the following methods:

- 05 a) Keyboard encoder integrated circuit
- b) Standard logic integrated circuits
- c) Microprocessor

The generation of output codes is in accordance with standard technique and is shown in a block circuit diagram in Figure 8. The letter keys are scanned as a 4 x 10 matrix giving an output at 56, and a key touch is interpreted by a keyboard encoder 55. The outputs 50, 51 and 52 of the NUMBERS, SHIFT and CONTROL keys 24 alter switching circuits 53 which transmit the relevant data along lines 54 to control the output from an encoder 55. Data is then passed on to a ROM 57 where it is converted into the appropriate standard ASCII codes. A Parallel to Serial Converter 58 converts the output to standard RS-232C format which is then transmitted over a cable 60 to the host computer.

There will now be described a number of alternative arrangements and modifications which may be provided in accordance with the invention.

A number of other different switch technologies are possible and a commercial version will conveniently use some sort of printed circuit technology rather than the discrete switches described in the preferred embodiment. Alternative switch technologies would include membrane type



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switches, capacitative switches and other sensory devices.

The wide range of available alternatives have in common that they are likely to have a short travel by comparison with traditional keyboard switches, or none at all, and are
05 likely to need only a low operating pressure in comparison with traditional keyboard switches.

The keyboard could incorporate a switch to switch between different character sets to enable the user to have access to a wide range of characters in addition to those
10 offered as standard, for example:-

Maths symbols

Foreign languages

Languages with different letters (Cyrillic, Greek, Arabic)

15 Editing commands for typesetting.

The switch labels for these different character sets could be changed at the same time as the character set is changed by sliding a key legend sheet in a space between the switches and any surface mouldings so that the
20 characters of the alternative character set and not the original ones were visible.

A left-handed version of the keyboard may be be a mirror image of the right-handed version. A keyboard could be conveniently built with a left-handed version and a
25 right-handed version on either surface of the same device, so that merely by turning the keyboard over its configuration is changed from one hand to the other.



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Two keyboards could be used in parallel as a two-handed device. This might offer some speed advantages over a single-handed version and should offer speed advantages over the traditional two-handed keyboard.

05 A keyboard could be constructed using mouldings between the keys as shown in Figure 3 to help with the delineation of the keys, with or without any mouldings actually on the keys themselves. These inter-key mouldings would help to guide the finger from one key to another and
10 provide feedback to the finger that it was properly registered on a key. These mouldings between the keys could also be used as a finger-rest position if the keyswitch switches themselves are so touch-sensitive that the fingers could not rest on the keys themselves without
15 triggering a character.

The keys could be positioned not in columns but on the diagonal as in Figures 3 and 4 which might have some advantages for making the sliding motion simpler. The number of keys allocated to each finger could be different,
20 and the little finger could be allocated letter keys of its own. All these variations are illustrated in Figure 4.

Whilst the embodiments shown assume that the keys would all be in the same surface plane, it may be desirable for them to be in different planes, with the surfaces for
25 use by each digit curved (probably convex) rather than flat, and with each digit in a different plane from the others. This helps to reduce the possibility of fingernails fouling on the keyboard and improve the comfort



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with which the keyboard can be used.

The layout of the key switches, that is to say the order in which they are arranged on the key surface, can be varied. Whilst the version on the embodiment shown is a
05 good solution for the English language, it may be varied in other circumstances. Whilst it would probably be desirable to have an international keyboard rather than variations for each country, it is also possible that the optimal
10 international keyboard, will be different from that displayed.

By the use of extra "NUMBER" keys (i.e. mode switching keys) it would be possible to increase the number of characters available on the keyboard. It could also be
15 desirable to increase or reduce the number of keys accessible to the fingers, which would also have implications for the number of NUMBERS keys and/or CONTROL and SHIFT keys, depending on the number of characters which it was thought necessary to have in a particular
20 repertoire. A version with only 16 letter keys is shown in Figure 5.

It may also be desirable to incorporate a separate HELP key as one of the ancillary keys which, when it transmits a particular code, will call up a HELP menu to
25 guide the user of the computer device.

The size of the keyboard could be changed. If it was necessary to make it much smaller it could be reduced



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considerably by placing the thumb keys or some of the thumb keys under the keys for the index finger by putting the NUMBERS key and one or more of the thumb keys on the side of the device rather than on the top surface so that they are operated by a gripping motion rather than a pressing motion. The reserved keys could also be removed and the ancillary keys removed or relocated to minimise the overall size of the keyboard. The size of individual switches could also be decreased.

05 Using these means it is possible to envisage a keyboard as small as 85mm by 90mm, or even smaller, although this would probably imply the loss of some ergonomic convenience.

10

The keyboard as a whole could be covered with an impermeable covering, if necessary, depending on the key technology, to protect the keyboard from dirt and to enable it to be washable.

15

The NUMBERS and indeed CONTROL and SHIFT keys could be operated by a different means from pressing a normal key: by rocking the keyboard itself between switches located on the underside of the key, (as shown in Figure 6, which is a cross-section of Figure 5), by using the heel of the hand, or even by using other parts of the body.

20

It would be possible to produce a keyboard to the same layout without the use of any surface mouldings, i.e. completely flat. This would be slightly cheaper to produce which could be advantageous in some circumstances, although it would be less easy to use quickly and would therefore be

25



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less suitable for other than very casual use.

Whilst in the embodiment shown the keyboard is discussed as a separate device for input to a computer or normal computer terminal, the keyboard could also be used
05 as the keyboard for a computer which was integral to the body of the keyboard itself, of a pocket translator, pocket video book, video games, control equipment in motor or other vehicles, etc. etc. The keyboard lends itself to building into other equipment where alphanumeric input
10 facility is desirable.

It would also be possible to use many other profiles for the mouldings on the keys, samples of which can be seen in Figure 7. Keys could be dome shaped, pyramidal with a round or flat top, multi-faceted, in fact any suitable
15 shape with suitably sloping sides.

Depending on the context of the keyboard and the direction from which the finger is designed to impact the key, the key could also rise to an outside edge, or even form a crescent-like bank, whether convex or concave in
20 cross-section (see Figure 7).

These different key profiles could use a multiplicity of different switch technologies including traditional moving switches, membrane switches with the moulded profile bonded to part of the striking surface, switches relying on
25 air pressure (the moulding would take the form of an airbag which would be deformed by finger contact to activate the switch), or foam (also acting to trigger the switch when it is deformed by finger contact). Mouldings could be created by applying a flexible film to a suitably shaped keyboard

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either premoulded or applied to the keyboard by a technology such as vacuum shrinking.

Returning to consideration of the modification of Figure 3, the contouring may consist of moulding 61 on the base of the keyboard to denote the top of the keying area, and moulding 62 to denote the bottom of the finger area. Mouldings 25 are provided as before to separate the keys for different fingers. Mouldings in the form of small projections 63 are provided to separate each key. In another alternative, not shown, the active touch sensitive area can be recessed below the level of the base, but in preferred form the moulding is built up on the surface between the keys as shown in Figures 1 and 3. As shown in Figure 3 the mouldings can be built up higher and continuously, for example to separate keys for different fingers, and the mouldings can be lower and/or non-continuous to separate keys which are intended to be used by the same finger. When they are not typing, the fingers can rest on suitably positioned and sized mouldings serving as rest pads.

This arrangement will make mis-keying less likely than on an ordinary typewriter. The moulding will guide the fingers towards the right location or, if mis-keying, away from the right location so that it becomes obvious that an error is being made before the actual touch-sensitive surface is touched. This enables keys to be spaced closer together than is usually the case. Any slight mis-aiming of the finger will cause the



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finger only to touch the inactive, non-sensitive area of the keyboard, that is to say the raised moulding, rather than touching another sensitive area and so registering the wrong character.

05 Such an arrangement lends itself to use of the sliding movement principle set out in accordance with the present invention. If the mouldings between adjacent keys are in the shape of suitably placed small projections, the finger can slide between them from one
10 key to another, and at the same time use the sensory feedback from the mouldings to know when the proper location is reached.

Returning now to consideration of the embodiment of Figures 5 and 6, elements which are in common between
15 Figures 5 and 1 are indicated by like reference numerals. There are provided three main columns of four letter keys 23 in each column, the columns being indicated by I, II and III and being allocated to the first, second and third fingers respectively. The right-hand column
20 is to be operated by the little finger and space shift lock and caps lock and special character keys are provided for the thumb bearing the same reference numerals as in Figure 1. A hand rest bar 71 is provided for the heel of the hand to rest on and an
25 enter key 72 is provided for use by the side of the hand. A key display may be provided at 73 to



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indicate letters.

Referring to Figure 6, mode switches 74, 75 and 76 are provided on the underside of the base 21 for operation by rocking movement of the whole base on the surface of a table indicated diagrammatically at 77.

The principle of operation is that the letters of the alphabet are divided into two or more sets which are allocated to different modes which can be selected by the rocking movement of the base. In any particular mode a series of letters of the alphabet can be selected by operation of the letter keys 23. Rocking of the base to a different mode allows selection of different letters by operation of the same letter key. The rocking or mode position is controlled by the weight of the heel of the hand resting on the raised bar 72 on the upper surface of the keyboard. The underside mode switch surfaces conveniently have a surface of non-slip material.

Conveniently the keys are recessed beneath the general level of the upper surface of the base 21. Only the central recessed part of all switches will be touch sensitive, and the fingers will be able to rest on the ridges between the key recesses.

By way of example three modes may be provided, mode 1 being for numerals, mode 2 for the 16 most common letters, and mode 3 for the less common letters and



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punctuation. A fourth mode (not illustrated) may be provided for editing commands. The shift key operated by the thumb will have the same effect as a normal shift key, changing lower case to capitals and numerals or
05 punctuation to other punctuation and signs.

Thus in principle a three mode keyboard will be able to access 96 ASCII codes ($3 \times 16 = 48$ in the lower case and 48 in the upper case).

Referring now again in more detail to Figure 7,
10 there are shown in diagrammatic form cross-sections through 13 keys referred to by the letters (a) to (m). The shapes shown in Figures 7(a) to (g) illustrate keys suitable for keying from both directions. The cross-sections shown in Figures 7(h) to (m) illustrate keys
15 suitable for keying from one direction only.

With regard to the second aspect of the invention concerned with contouring, it will be appreciated that different contouring for different keys can be achieved by shaping the keys differently from each
20 other, or by having some keys of the same shape but orientated differently relative to the user of the keyboard.



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Although it will be appreciated that many variations of keyboard may be provided in accordance with the present invention, it is possible in preferred embodiments to provide at least to a degree the following advantages. A keyboard may be provided for which no training is required to use it usefully, that is to say that even an unskilled person coming straight to the keyboard can obtain some useful output. A keyboard can be arranged to be easy to learn at all levels of skill and speed, compared with other keyboards, and can be made fast and accurate to use after any given length of training comparable with training for other available keyboards. The keyboard can be made flexible i.e. able to output at least as wide a range of characters as are normally required in information processing, including foreign language and multi-language applications.

In preferred arrangements the keyboard will be usable by one hand, freeing the other hand for other purposes such as telephone use, but without causing more fatigue than traditional keyboards. However in some arrangements two keyboards embodying the invention may be provided for extra speed in some typing situations.

Embodiments may be produced of small size, suitable for pocket and portable equipment and less obtrusive on the desk, and may be produced on sound ergonomic principles to discourage error and reduce fatigue.



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CLAIMS

1. A keyboard for operation by human hand digits to signify letters of an alphabet by generating signals indicative of the letters, comprising
- a base,
- 05 a plurality of keys including a plurality of letter keys each operable by a human digit to signify a letter, in which
- any one of all of the letters of the alphabet concerned can be signified by operation of only a single
- 10 human hand without substantial movement of the whole hand across the keyboard,
- the configuration of the keys and/or the configuration in which the letters are allocated to the letter keys is or are related to the shape of a single human hand, and
- 15 in which there are provided a plurality of letter keys, referred to as principal letter keys, positioned to be associated with the three strongest fingers of the human hand, in which at least a majority of the letters of the alphabet, including the most commonly used letters,
- 20 are allocated to the principal letter keys, and in which operation of ~~no more than one at a time of the principal~~ letter keys is required when signifying any letter of the



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alphabet.

2. A keyboard according to Claim 1 in which the said configuration of the keys is related to the shape of a single human hand at least in that the keys are positioned
05 to take account of the difference in length between the longest finger and the other two strongest fingers of the human hand so as to allow the three strongest fingers to rest comfortably on three keys, or on three transverse pairs of keys, respectively, of three different groups
10 of principal letter keys when the hand is at rest.

3. A keyboard according to Claim 2 in which the keys are arranged in a matrix of columns of keys generally longitudinal of the fingers and rows of keys generally transverse of the fingers, and in which the said
15 comfortable rest position of the three strongest fingers is achieved at least in part by arranging the transverse rows to be curved or stepped.

4. A keyboard according to Claim 2 in which the keys are arranged in a matrix of columns of keys generally
20 longitudinal of the fingers and rows of keys generally transverse of the fingers, in which the said comfortable rest position of the three strongest fingers is achieved at least in part by having the pitch between transverse rows of keys substantially equal to the difference in
25 length between the longest finger and the other two strongest fingers of the human hand.



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5. A keyboard according to Claim 1 in which the said configuration in which the letters are allocated is arranged so that the most commonly used letters can be signified by the operation of principle letter keys at
05 or close to the natural rest position of the three strongest fingers of the human hand.
6. A keyboard according to Claim 1 in which the said principle letter keys are arranged in three groups positioned for the groups to be associated respectively
10 with the three strongest fingers of the human hand.
7. A keyboard according to Claim 6 in which each said group of letter keys comprises at least one column of three or more letter keys positioned to allow keys of the column to be reached by movement of a human finger
15 forward and backward relative to the body of the user.
8. A keyboard according to Claim 1 in which all the letter keys are positioned for operation, in normal use, by the fingers of the human hand.
- 20 9. A keyboard according to Claim 1 in which all the letter keys are arranged as principle letter keys, in which all the letters of the alphabet are allocated to principle letter keys, and in which any letter of the alphabet can be signified by an action consisting only
25 of operation of one, appropriately selected, letter key.
10. A keyboard according to Claim 1 in which the keyboard



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- includes mode selector means operable by movement of the said single human hand without substantial movement of the whole hand across the keyboard, said mode selector means being operable to select different modes for the
- 05 letter keys such that operation of a letter key in different modes causes the switch means to generate signals indicative of different letters, and/or different forms of the same letter, and/or different non-letter items of information.
- 10 11. A keyboard according to Claim 10 in which the letters of the alphabet concerned are divided into two or more classes of letters selectable in respective modes by the mode selector means, in which the letter keys are operable to signify different letters from different classes
- 15 depending on which class has been selected by the mode selector means, and in which any letter of the alphabet concerned can be signified by operation of only a single letter key at a time, provided that an appropriate mode selection is made by operation of the mode selector
- 20 means.
12. A keyboard according to Claim 10 in which the said mode selector means comprises a mode-key positioned for operation, in normal use, by a human digit other than the three strongest fingers of the human hand.
- 25 13. A keyboard according to Claim 10 in which the said mode selector means comprises a switching device



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associated with the said base of the keyboard and operable by a rocking motion of the said base and arranged to be operated in normal use by a rocking motion of the whole said single human hand.

- 05 14. A keyboard according to Claim 1 in which the base and/or at least some of the keys is or are contoured in such a manner as to effect or enhance operation of the keyboard during substantially planar movement of a digit of the human hand consisting of movement substantially in or parallel to the plane of the keyboard.
- 10 15. A keyboard according to Claim 14 in which the said contouring is such as to enforce or assist movement of a human digit from one key to another of certain predetermined sets of keys, and/or to prevent or inhibit
- 15 movement of a human digit from one key to another of certain predetermined sets of keys, during said substantially planar movement of a human digit.
16. A keyboard according to Claim 15 in which said contouring is arranged to prevent or inhibit said substantially planar movement of a human digit between
- 20 the keys of the group of letter keys with which that digit is normally associated to the keys of another group.
17. A keyboard according to Claim 16 in which the
- 25 said contouring comprises a raised barrier portion or portions of the base running between adjacent groups



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of keys.

18. A keyboard according to Claim 15 in which the keys are arranged in a pattern in which certain sets of keys are operable to signify letters which commonly occur in sequence, and said contouring is such as to enforce or assist movement of a human digit from one to another of the keys in a set related to such a sequence, during said substantially planar movement of the human digit.

19. A keyboard according to Claim 14 in which at least some of the keys are contoured to provide a surface inclined to the horizontal for contact by a human digit such that during said substantially planar movement a force derived from the planar movement of the digit is translated by the inclined surface of the key into a force generally at right angles to the plane of the keyboard to operate the key.

20. A method of generating signals indicative of letters of an alphabet by operating letter keys of a keyboard by touch of human digits on the keys and by generating signals indicative of letters by actuation of switch means associated with the keys, the method comprising the steps of

signifying any of all of the letters of the alphabet concerned by operation of only a single human hand without substantial movement of the whole hand across the keyboard,



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operating the keys when arranged on the keyboard in such a manner that the configuration of the keys and/or the configuration in which the letters are allocated to the letter keys is or are related to the shape of a
05 single human hand, and

associating a plurality of letter keys, referred to as principal letter keys, with the three strongest fingers of the human hand, at least a majority of the letters of the alphabet, including the most commonly
10 used letters, being allocated to the principal letter keys, and signifying any one of all of the letters of the alphabet by operation of no more than one at a time of the principal letter keys.

21. A method according to Claim 20 in which the said
15 principal letter keys are arranged in three groups, and including the step of associating the three groups of principle letter keys respectively with the three strongest fingers of the human hand.

22. A method according to Claim 21 in which each said
20 group of letter keys comprises at least one column of three or more letter keys and in which the method includes the steps of reaching the different keys of the column by movement of a human finger forward and backward relative to the palm of the human hand.

25 23. A method according to Claim 20 in which all the letter keys are arranged as principle letter keys, in



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- which all the letters of the alphabet are allocated to principle letter keys, and including the step of signifying any letter of the alphabet by an action consisting only of operation of one, appropriately selected, letter key.
24. A keyboard for operation by digits of one or both human hands to signify units of information by generating signals indicative of the units of information, comprising
- 10 a base, and
a plurality of keys operable by human digits,
the base and/or at least some of the keys being contoured differently in respect of different keys in such a manner as to effect or enhance operation of the
- 15 keyboard during substantially planar movement of a digit of the human hand consisting of movement substantially in or parallel to the plane of the keyboard.
25. A keyboard according to Claim 24 in which the said contouring is such as to enforce or assist movement of
- 20 a human digit from one key to another of certain predetermined sets of keys, and/or to prevent or inhibit movement of a human digit from one key to another of certain predetermined sets of keys, during said substantially planar movement of a human digit.
- 25 26. A keyboard according to Claim 25 in which the keys are arranged in a pattern providing groups of keys,



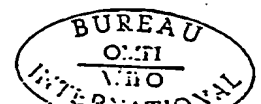
- 55 -

the keys of each group being positioned for operation selectively by a single human digit associated in operation with that group, and said contouring is arranged to prevent or inhibit said substantially planar movement of the human digit between the keys of the group with which the digit is normally associated to the keys of another group.

27. A keyboard according to Claim 26 in which the said contouring comprises a raised barrier portion or portions of the base running between adjacent groups of keys.

28. A keyboard according to Claim 24 in which the keys are arranged in a pattern in which certain sets of keys are operable to signify letters or other units of information which commonly occur in sequence, and said contouring is such as to enforce or assist movement of a human digit from one to another of the keys in a set related to such a sequence, during said substantially planar movement of the human digit.

29. A keyboard according to Claim 24 in which at least some of the keys are contoured to provide a surface inclined to the horizontal for contact by a human digit such that during said substantially planar movement of a human digit, a force derived from the planar movement of the digit is translated by the inclined surface of the key into a force generally at right angles to the plane of the keyboard to operate the key.



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30. A method of generating signals indicative of letters of an alphabet or other units of information by operating letter keys of a keyboard by touch of human digits on the keys and by generating signals indicative of letters by actuation of switch means associated with the keys, the method including the step of

operating certain sets of keys which signify letters or other units of information which commonly occur in sequence, said operation being effected by moving a human digit from one to another of the keys in such a set by a substantially planar movement of the human digit consisting of movement substantially in or parallel to the plane of the keyboard.

31. A method of generating signals indicative of units of information by operating keys of a keyboard by touch of human digits on the keys and by generating signals indicative of other units of information by actuation of switch means associated with the keys, the method including the step of

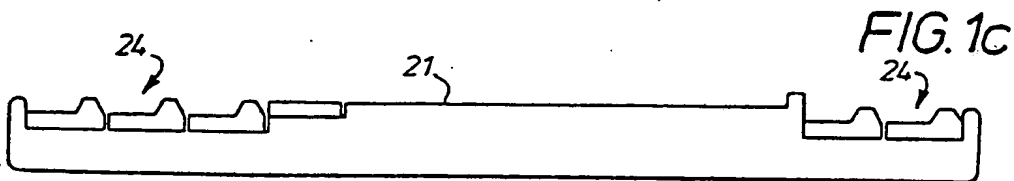
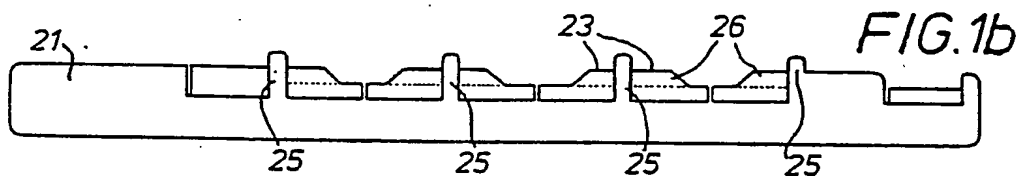
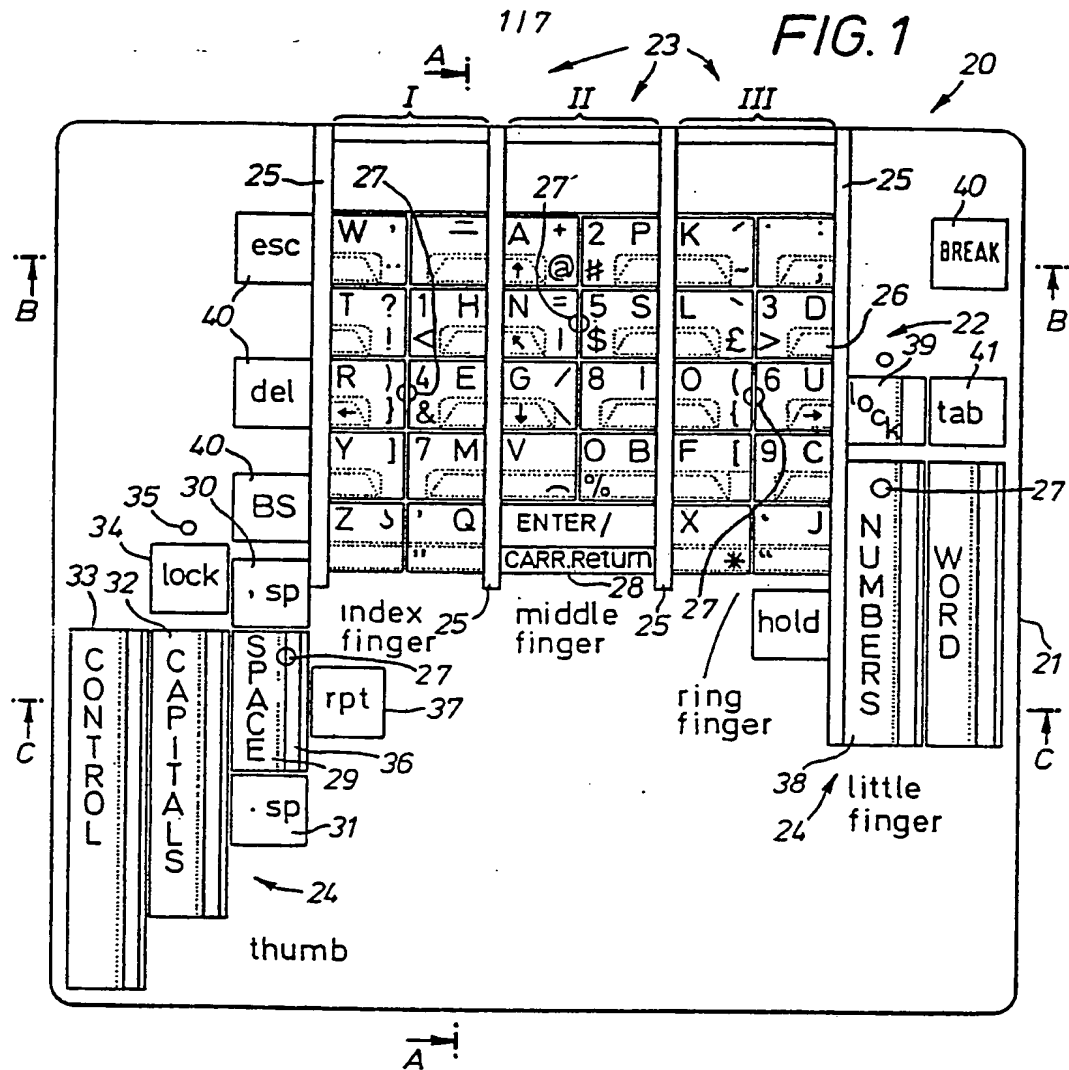
operating a key by a substantially planar movement of a human digit consisting of movement substantially in or parallel to the plane of the keyboard, the operation comprising contacting the human digit against an inclined surface of the key during the said planar movement, and translating, by the effect of the inclined surface, a force derived from the planar movement of the digit into a

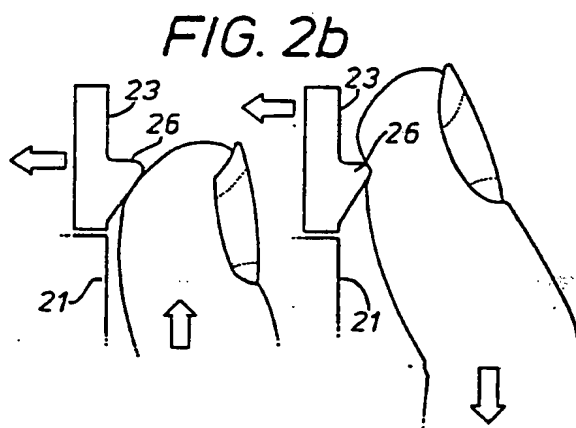
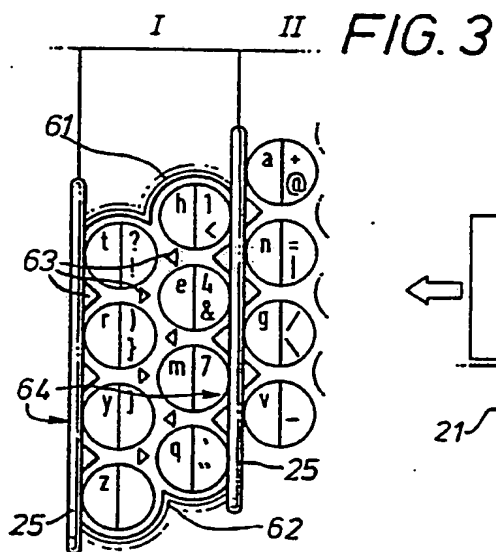
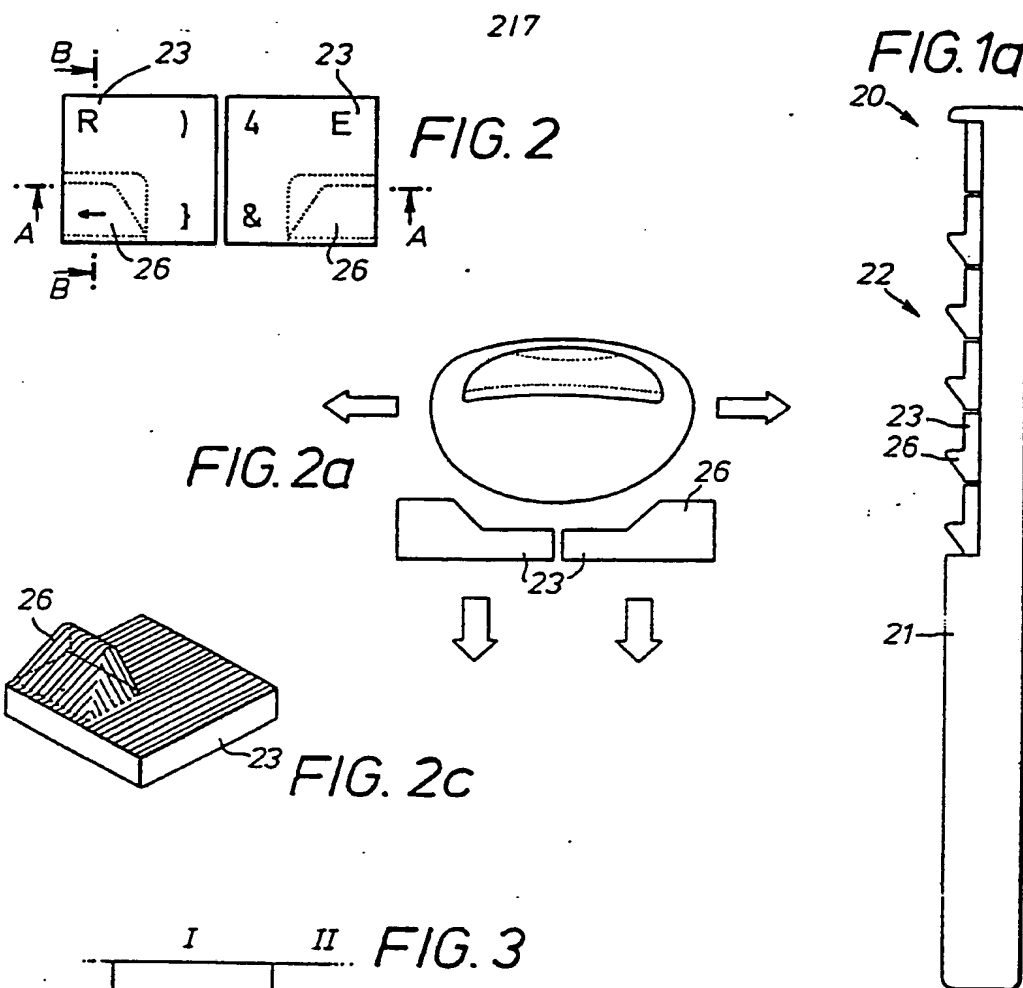


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force generally at right angles to the plane of the
keyboard to operate the key.







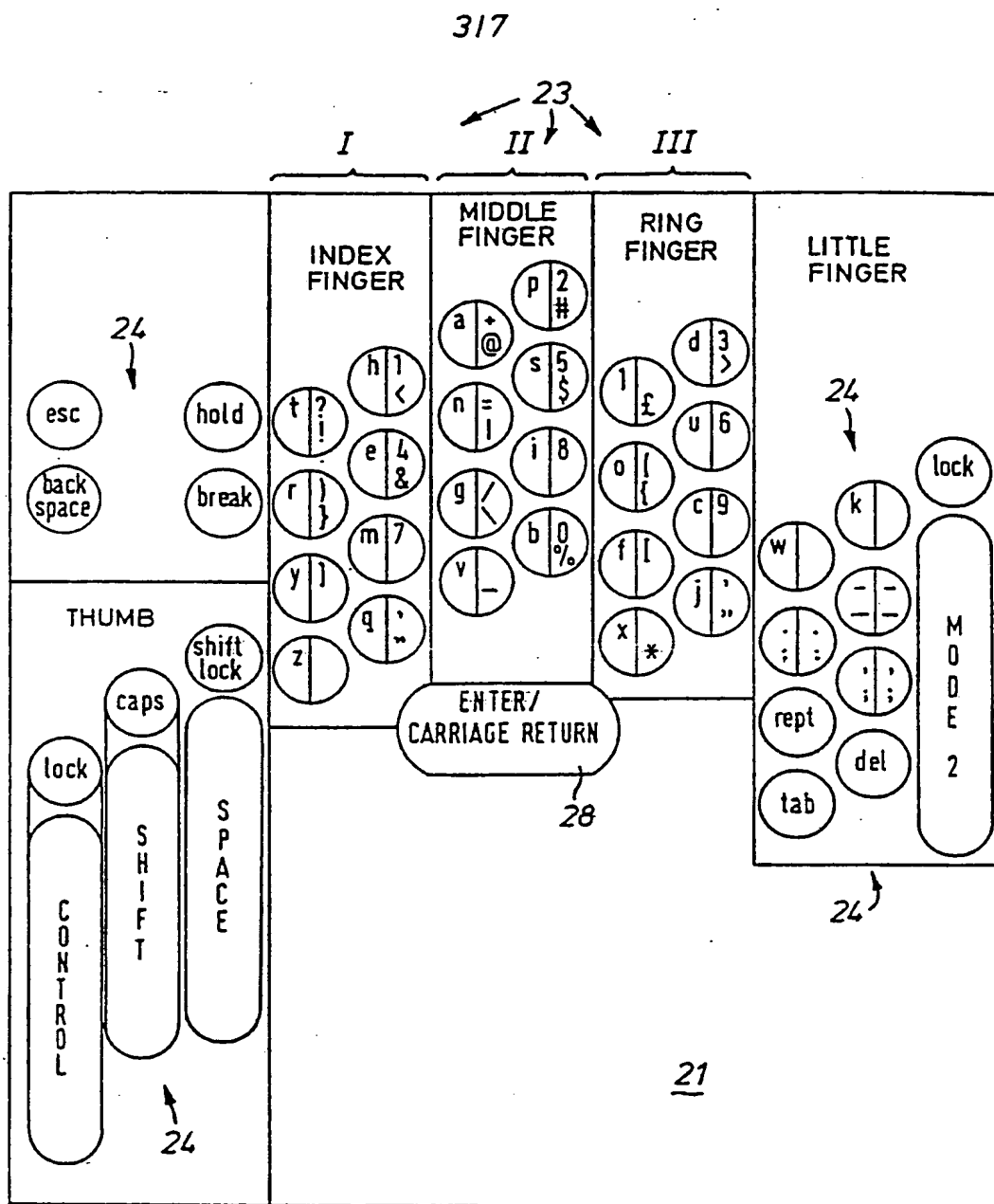


FIG. 4

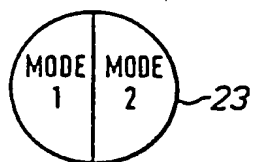


FIG. 4a

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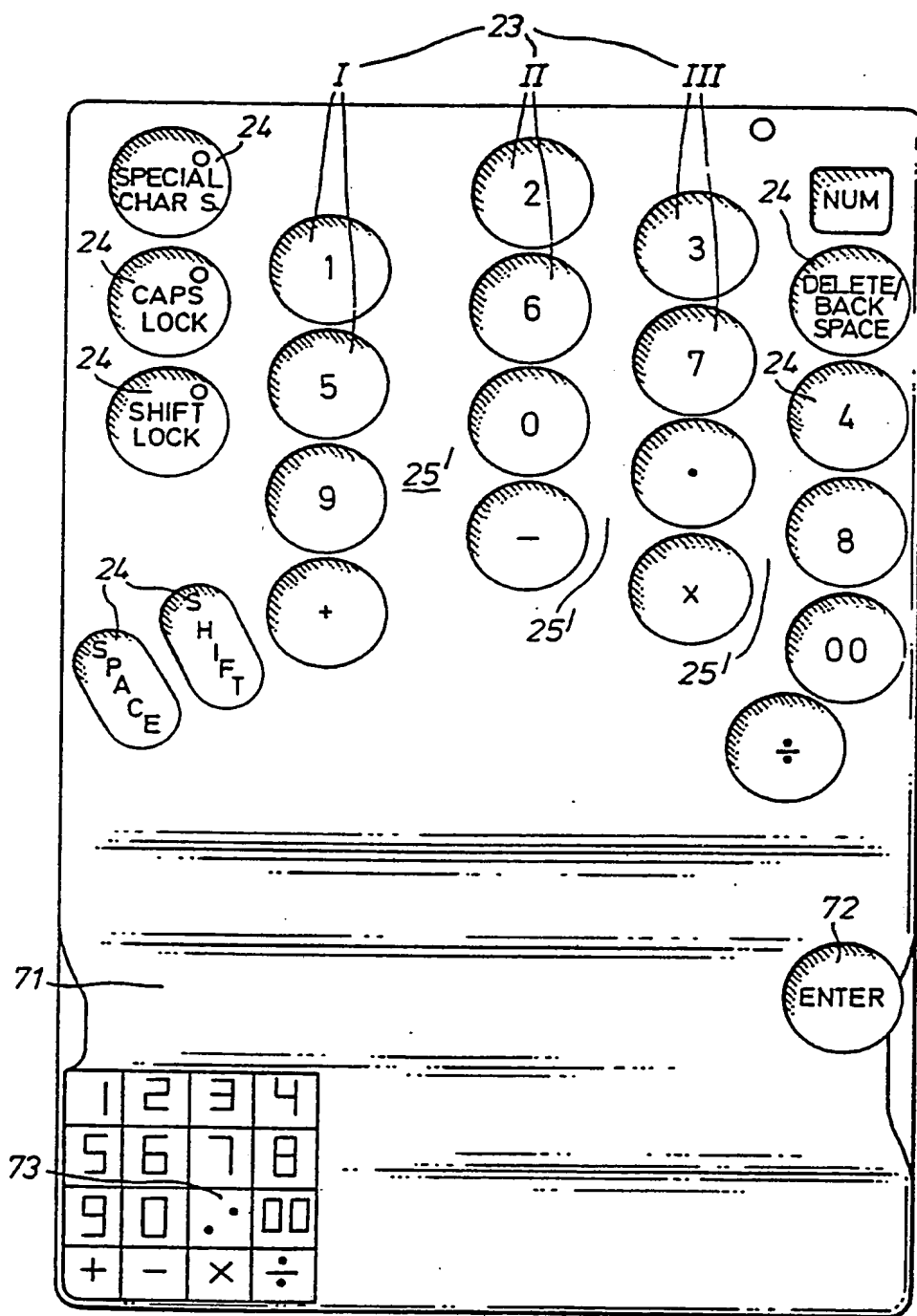


FIG. 5



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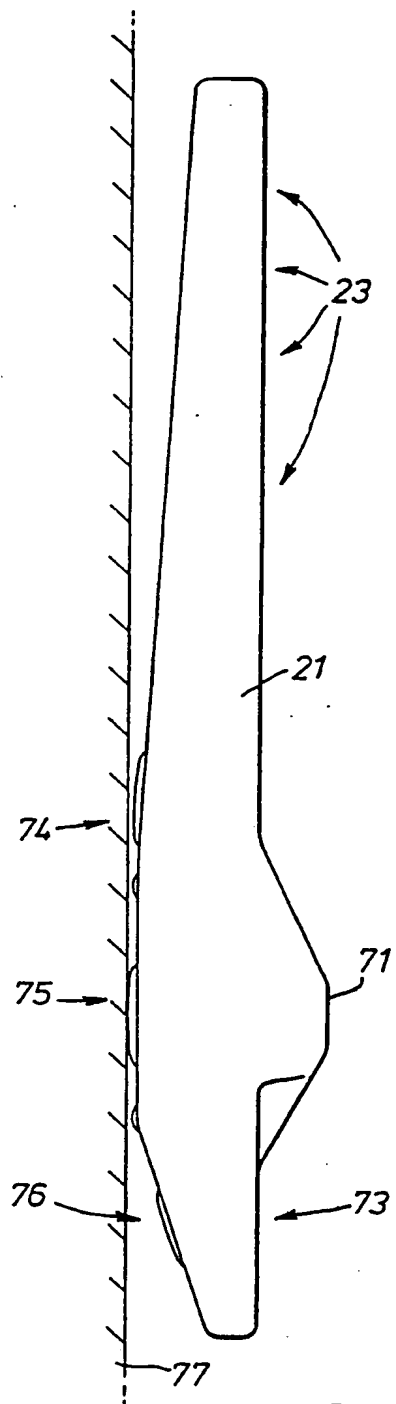


FIG. 6

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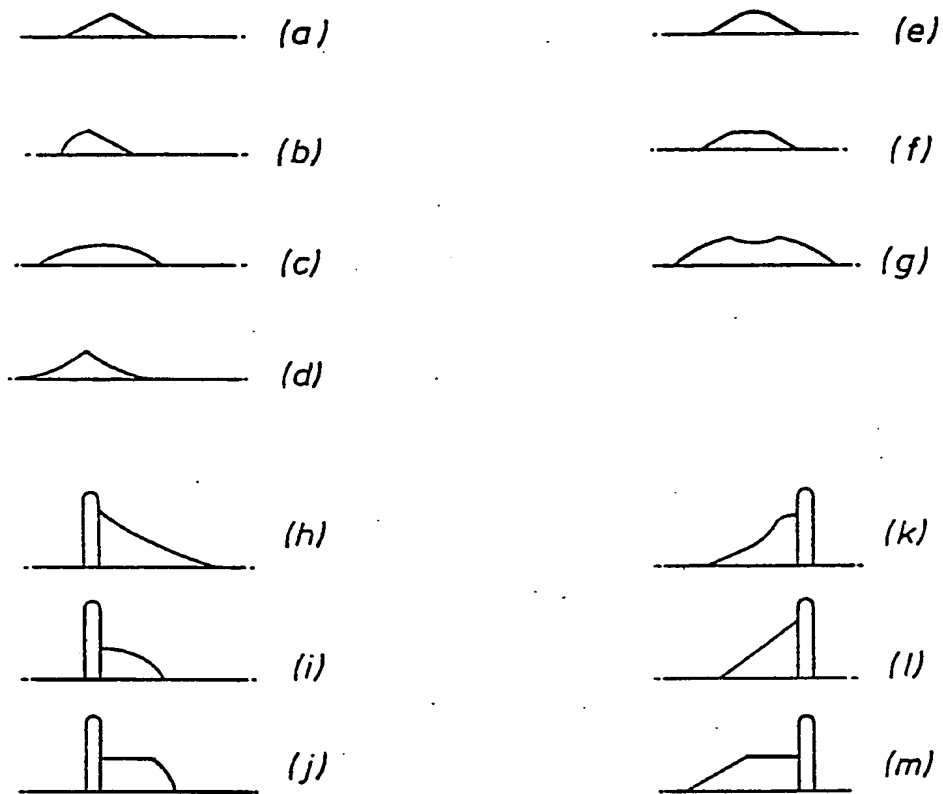


FIG. 7

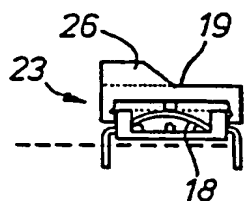


FIG. 9

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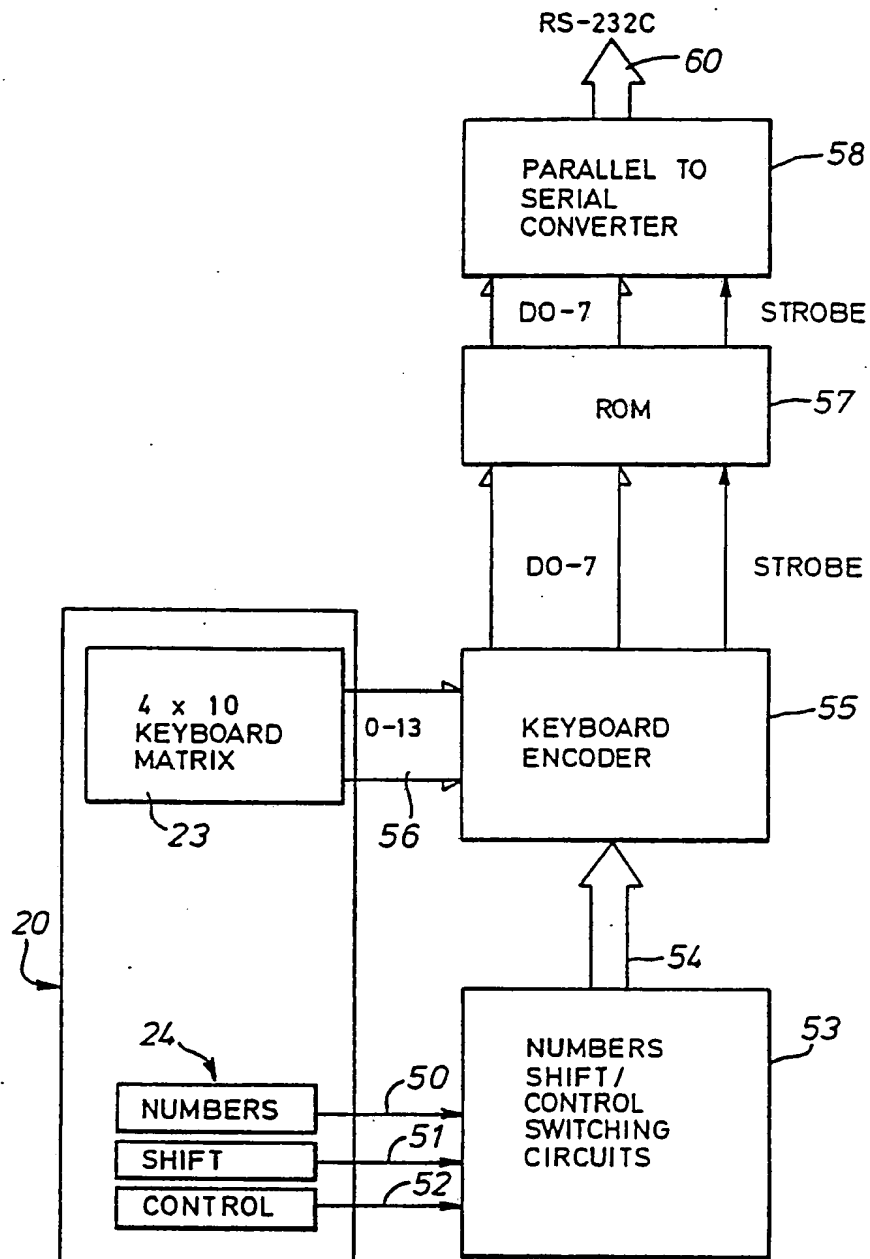
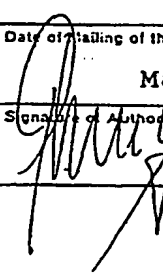


FIG. 8

SUBSTITUTE SHEET

INTERNATIONAL SEARCH REPORT

International Application No. PCT/GB 81/00013

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) *		
According to International Patent Classification (IPC) or to both National Classification and IPC		
Int.Cl. ³ : B 41 J 5/10		
II. FIELDS SEARCHED		
Minimum Documentation Searched *		
Classification System	Classification Symbols	
Int.Cl. ³	B 41 J	
Documentation Searched other than Minimum Documentation to the extent that such Documents are included in the Fields Searched *		
III. DOCUMENTS CONSIDERED TO BE RELEVANT ¹⁴		
Category *	Citation of Document, ¹⁶ with indication, where appropriate, of the relevant passages ¹⁷	Relevant to Claim No. ¹³
	GB, A, 1016993, published January 12, 1966, see page 1, line 13 to page 3, line 52, figures 1-9, I.B.M. Corp.	1, 2, 3, 4, 7, 8, 9, 20, 21, 22
	FR, A, 1567411, published May 16, 1969, see the whole document, F. Fuchs	14, 15, 16, 19, 24, 25, 29, 31
A	FR, A, 2360427, published March 3, 1978, see figures 1-13, IDF Comp.	
A	US, A, 3332527, published July 25, 1967, see the whole document, R.M.J. Place	
<p>* Special categories of cited documents: ¹⁵</p> <p>"A" document defining the general state of the art</p> <p>"E" earlier document but published on or after the international filing date</p> <p>"L" document cited for special reason other than those referred to in the other categories</p> <p>"O" document referring to an oral disclosure, use, exhibition or other means</p> <p>"P" document published prior to the international filing date but on or after the priority date claimed</p> <p>"T" later document published on or after the international filing date or priority date and not in conflict with the application, but cited to understand the principle or theory underlying the invention</p> <p>"X" document of particular relevance</p>		
IV. CERTIFICATION		
Date of the Actual Completion of the International Search *		Date of Mailing of this International Search Report *
May 8, 1981		May 26, 1981
International Searching Authority ¹ EUROPEAN PATENT OFFICE Branch at The Hague P.O.Box 5518 Patentlaan, 2 2280 HV FLIJSWIJK (ZH) The Netherlands		Signature of Authorized Officer ²⁰  G.L.M. Kruidenberg